

Social and organizational learning in the adaptation to the process of climate change: The case of a Brazilian thermoplastic resins and petrochemical company

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ABSTRACT

Since climate change involves uncertainty, complexity and massive, rapid disruptions, companies seeking to adapt need to search for specific and non-traditional knowledge. Social learning approaches have emerged as a promising way to address the issue of adaptation to climate change. This paper examines the structuring of a business strategy for adaptation in a Brazilian thermoplastic resin and petrochemical company to exemplify the extent to which internal changes in the organization's understanding, norms and values derived from a social learning process. Hence, the main research question is **“how are learning processes within a company—organizational learning—and social interaction in a Community of Practice—social learning—related and how do they contribute to leveraging changes in management practices in a company's adaptation to climate change?”** The case study presents how the company's representatives' participation in a social learning process within a CoP supported not only the development of a comprehensive adaptation strategy but also the mainstreaming of climate concepts, impacts and adaptation actions. Therefore, it demonstrated that combining social learning and organization learning processes is useful to consistently build resilience, given that they are mutually supportive in the recognition of the relevance of adaptation, the dissemination of risk perception throughout the organization and the development of an internal capacity to continuously plan and act.

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1. Introduction

Adapting to climate change events and effects is a recent and disruptive agenda for businesses. It requires a shift in two management paradigms: i) from a specialized to a systemic approach, and ii) from viewing socioenvironmental systems as public policy matters to seeing them as a shared — public-private — responsibility (Linnenluecke et al., 2012). In addition, a longer-term approach than that usually adopted in strategic planning is necessary in adaptation projects, and companies face a lack of internal abilities, competencies and resources to create organizational adaptive capacity (Orsato et al., 2015).

Abbreviations: CoP, Community of Practice; FGV, Fundação Getulio Vargas; EPC, Business for Climate Platform; GHG, Greenhouse Gases; SL, Social Learning.

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Since climate change involves **uncertainty, complexity and rapid massive disruptions, companies seeking to adapt are required to search for specific and nontraditional knowledge. Social learning (SL)**, as an approach that promotes the interaction of social groups while transmitting information or exchanging experiences and ideas, has emerged as a **promising way to address such issues.**

Aware of this context, in 2014, the Center for Sustainability Studies of Fundação Getulio Vargas (FGVces) proposed to member companies of the **Business for Climate Platform (EPC)**, Portuguese acronym for Business for Climate Platform), in Brazil, a **Community of Practice (CoP)** dedicated to fostering applied research, gathering stakeholders and providing an exchange environment in which **member companies could learn about adaptation to climate change and offer mutual help by co-creating knowledge and solutions in the process of developing adaptation strategies.** A CoP is here understood as the **“engagement in the processes of social practice or in creating collectively-negotiated shared**

repertoires and shared purpose" (Salter and Kothari, 2016, p. 5).

This learning process of participating in the CoP and the resulting framework to support the structuring of business adaptation plans provoked a **Brazilian thermoplastic resins and petrochemical company** to inaugurate, in 2015, a process of **internalizing the agenda and mainstreaming this adaptation strategy throughout the whole company**.

This paper examines that case study in order to answer and exemplify the research question **"how do the learning processes within a company – organizational learning – and the social interaction in a CoP – social learning – relate and contribute to leverage changes in management practices for company adaptation to climate change?"** Hence, it first aims to contribute to the current debate regarding a growing need for companies to efficiently manage climate change impacts by demonstrating combined social and organizational learning as supportive of such a process. Second, by diving into the organizational level within the SL approach, the paper addresses the gap in current studies regarding (i) the proofs of the effectiveness of SL processes at the organizational level, and (ii) the understanding of how organizational learning happens, fostered by the social level and anchored in the individual one.

After presenting the conceptual bases of the organizational and SL approaches and explaining the method through which the in-depth theory generation case study was developed, the following sections provide the case findings regarding the main analytical categories identified as relevant to understand the social and organizational learning processes and discuss the SL value creation as well as the inter-related organizational and SL processes.

2. Literature review

2.1. From organizational to social learning

Scholars dedicated to the study of climate change point to the challenges and difficulties that firms face in implementing actions and policies "that were once regarded as belonging to government" (Scherer et al., 2009, p. 328). Adapting to climate change events and effects requires firms to rebuild activities and operations, as well as to make major adaptations at the strategic, organizational and operational levels (Fortis et al., 2018). To achieve such adaptations, firms need to promote change in the organization's knowledge base and behavior (Maon et al., 2010). Organizational learning has been emphasized as central to improving the firms' ability to address climate change impacts (Fortis et al., 2018).

The definition of what constitutes learning has been the subject of several theories (Armitage et al., 2009), with emphasis on individual, group, and organizational learning (Kilpatrick et al., 2002). Learning can be seen as a continuous and active process through which learners use knowledge to change their ideas and behavior in relation to their environment (Atkinson-Palombo and Gebremichael, 2012; Henry, 2009) and the way in which individuals or groups acquire the capacity to adapt to different conditions (Ofei-Manu and Shimano, 2012).

Organizational learning, in turn, can be understood as the **process by which organizations generate, disseminate, exploit, and translate knowledge, upgrading the organization's skills, expertise, and competencies** (March, 1991; Meeus et al., 2001). Many theories suggest that organizational learning is a critical constituent part of innovation processes (Cohen and Levinthal, 1990; Hurley and Hult, 1998) and organizational competitiveness (Kaplan and Norton, 1992; Osterloh and Frey, 2000).

Conventional theories of organizational learning emphasize the cognitive, behavioral, abstract and individualistic aspects of learning (Huber, 1991; Zahra and George, 2002). According to these

theories, when the learning process is embedded among the members of an organization, a learning orientation or culture is established and organizational learning occurs (Yeung et al., 2007).

This Cartesian view of learning has already been contested by other theories such as Situated Learning (Lave and Wenger, 1991), which emphasizes the relational aspects of learning within CoPs in contrast to the individualist assumptions of conventional theories (Handley et al., 2006). A CoP is constituted by **"engagement in the processes of social practice or creating collectively-negotiated shared repertoires and shared purpose"** (Salter and Kothari, 2016, p. 5). Engagement in a CoP fosters a sense of community, identity and belonging (Wenger, 2000). Social practice that takes place in a community encompasses both explicit (tools, language, role-definitions) and tacit (conventions, assumptions, values) concepts (Handley et al., 2006).

Interactive learning through the formation of a learning CoP (Brown and Duguid, 1991; Haldin-Herrgard, 2000) is recognized as a factor that facilitates organizational learning (Ortiz et al., 2008). Learning is generated through integrative interactions with the world (Salter and Kothari, 2016) and involves both individual and collective practices (Lam, 2000). According to this view, learning within a practice environment is not a strictly individual process (Salter and Kothari, 2016). Instead, learning is social, and it is as much about social culture, context and lived experience as it is about the acquisition of specific facts or technical skills (Wenger, 2000).

Reed et al. (2010, p. 5) define SL as the **"change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks."** It is a process through which individuals experience a change in understanding that is brought about by social interaction (Ofei-Manu and Shimano, 2012).

2.2. Social learning for wicked problems

Wicked problems are those regarded as complex, intractable, open-ended, and unpredictable (Alford and Head, 2017) because of their dynamic and evolving nature during the problem-solving process. As a wicked problem, **adaptation to climate change at the organizational level challenges existing organizational learning practices** (Campos et al., 2016).

Recent literature has demonstrated that, when dealing with climate change problems, the entire process of organizational learning requires a different approach (Campos et al., 2016; Storbjörk, 2010). Previous studies have shown that climate adaptation is largely dependent on communication and interaction between different actors and organizations (Storbjörk, 2010) and on cooperation to foster new forms of learning in which institutional actors have an important role as mediators of collective learning (Armitage et al., 2011).

SL implies that organizational actors address climate change issues through social interactions and relationships that take into account a **shared understanding of the problems at stake** (Pahl-Wostl et al., 2008). SL methods are being used and evaluated in varied contexts including areas such as the collaborative management of natural resources and global environmental change (Armitage et al., 2009, 2011; Rodela, 2011). What these methods have in common is a **focus on establishing dialogue and exchange with key and interdependent actors and on fostering a collaborative learning approach under complex conditions** (Shaw and Kristjansson, 2014).

Thus, SL initiatives point to new ways of working with multiple stakeholders and to the need to acknowledge complex concerns (Maon et al., 2009) and to interpret and translate these concerns

into organizational practices (Basu and Palazzo, 2008). Stakeholder-inclusive decision-making requires firms to modify their knowledge base and “achieve effective use of internal and external, explicit and tacit knowledge” by learning from their internal and external environment (Fortis et al., 2018, p. 281).

2.3. From social to organizational learning

Current inquiry into SL investigates how learning occurs, the extent to which participatory processes make SL available, how best to design processes to facilitate learning and the ways that learning may lead to positive outcomes (Kristjanson et al., 2014; Rodela, 2011). Existing studies have shown **how firms acquire relevant knowledge by interacting with other firms, but it still remains unclear how this learning constitutes the knowledge basis that firms acquire** (Fortis et al., 2018).

Reed et al. (2010) outline three defining characteristics of SL: (1) a change in understanding and practice occurs; (2) the scale of change is extended beyond individuals and small social units; and (3) learning occurs via social networks. Muro and Jeffrey (2012) also provide a summary of categories and types of collaborative network conditions for promoting SL relating, for instance, to the characteristics of involved stakeholders' networks, properties of collaborative processes, and properties of knowledge. Pelling and High (2005) propose an interactive **model for organizational learning and adaptation where four spaces of influence shape adaptive outcomes: social context, learning, adaptive capacity and adaptive actions**. The relations between these four spaces determine organization and individual adaptive actions.

Similarly, Wenger et al. (2011) propose the concept of **value creation**. According to this **five-cycle model**, SL can be generated in the following cycles: (1) **immediate SL**: the experience of the community's activities and interactions among members; (2) **potential SL**: the knowledge capital to be realized later; (3) **applied SL**: knowledge capital applied to a specific situation; (4) **realized SL**: improvement in the performance, or reflection about the effects of learning on the performance, and (5) **reframing SL**: reconsideration of strategies, goals and values. However, **the effectiveness of SL processes at the organizational level has proved difficult to assess** due to the complexities related to the analysis of the extent to which internal changes in stakeholders' understanding, norms and values have taken place (Medema et al., 2016).

Although SL has been widely used in studies of natural resources management, **there is still a lack of research that would address the dynamic and elements of the organizational level within SL to adapt to environmental issues** (Lebel et al., 2010). From the social system to the organizational system level, the recent growing literature goes through conceptual frameworks of governance regimes for multilevel learning processes (e.g., Pahl-Wostl, 2009), dissects the SL dynamics between organizations capable of emerging adaptive co-management (e.g., Berkes, 2009), bridges the SL theory and the institutional aspects of multilevel environmental governance (e.g., Pelling et al., 2008) and demonstrates the centrality of SL for corporate anticipatory adaptation to climate change (e.g., Orsato et al., 2018). **Advancing in this path, this paper explores the linkage between organizational and social learning for adaptation and reveals the practicalities of how SL is embedded at the organizational level, building upon questions of how to increase the capacity for integrating considerations of climate change from CoPs into firms' routines and procedures for strategizing, planning and practicing** (Urwin and Jordan, 2008).

3. Research design

3.1. Case study background

The EPC is a corporate initiative led by FGV, a Brazilian business school. Since 2009, the initiative has gathered companies in a network with the objective of mobilizing, sensitizing and educating private sector managers and leaders for the management and reduction of greenhouse gas emissions (GHG) and risks associated with climate change. In the course of the initiative, the EPC constituted itself as a CoP to promote organizational strategies to adaptation to climate change among Brazilian corporations (Campos et al., 2016).

In 2014, the EPC developed, along with a group of 35 member companies, a framework for the development of business agendas on climate change adaptation (Fig. 1).

The framework is meant to support managers in understanding businesses' vulnerabilities and risks regarding climate change in a more comprehensive way, identify and prioritize adaptation measures, and elaborate adaptation plans aimed at increasing companies' resilience and at building adaptive capacity by cooperating with relevant stakeholders.

Since 2014, eight companies have implemented the framework and have built corporate adaptation strategies. Among them, Braskem is the only one that has been expanding its action plan, monitoring and evaluating the measures, and linking climate change to its core business.

3.2. The Braskem case

Created in August 2002, Braskem is part of the chemical and petrochemical industry; its production focuses on polyethylene, polypropylene and polyvinylchloride resins and on basic chemical inputs and green polyethylene produced from sugarcane (Braskem, 2018). Climate change is material to Braskem, as it could significantly impact its operations, competitiveness and consequently its financial profits. Thus, the company detected the need for structuring and reviewing management practices related to climate change, and it also identified a lack of methodology and tools internally to support this process.

In this context, Braskem joined the EPC initiative to further advance its business sustainability management practices focused on climate change (EPC, 2017).

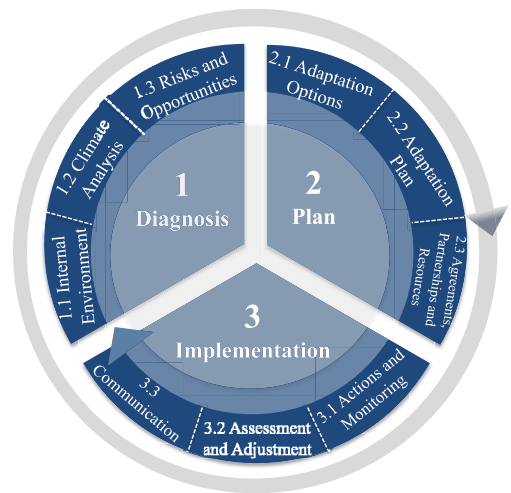


Fig. 1. The EPC framework for the development of business agendas on climate change adaptation.

Source: FGVces (2015).

3.3. Case study method

This study explores Braskem's efforts to structure a business climate change adaptation strategy. Its goal is to test concepts from the literature and build up the relationships among them, enhancing the theory on organizational learning and expanding it by bridging social and organizational learning processes.

For this research, we use a **single case study approach** (Eisenhardt, 1989; Yin, 2008) employing an embedded design – exploring the same issue in a variety of contexts within the same firm (Eisenhardt, 1989; Frohlich et al., 2002) – based on a process of **qualitative data analysis** through multiple data collection methods. It is a longitudinal research study as the data collection and analysis took four years to achieve, from the beginning of 2014 to the end of 2017, thereby offering a great opportunity to observe the relationships among events (Frohlich et al., 2002). Two investigators participated in all stages, and one other brought an “outsider perspective” to the data analysis (Gioia et al., 2013).

3.4. Data collection

Given the importance of combining data collection techniques, as pointed out by Eisenhardt (1989), Bryman and Bell (2011) and Saunders et al. (2009), to develop a case study, **we based our data analysis on semistructured interviews, participant observations in workshops, working group meetings and other events, bilateral interactions throughout the application of the EPC framework and reviews of public and private archives.**

The interactions with Braskem were mainly with the company's sustainable development (SD) manager, who led the adaptation strategy development process, and involved at various points the SD director and analyst. Table 1 summarizes the interactions per year.

While the EPC events were the source of information on the overall context for Braskem's adaptation efforts and on the facts, challenges and achievements that the firm communicated to the working group, the interviews and archive analysis offered data to help understand ‘why’ and ‘how’ the facts happened in the specific way they did. This documentary analysis assisted the authors in their understanding of the corporate policies and practices and helped with triangulation.

3.5. Data analysis

From the field notes, interview transcriptions and relevant excerpts from company documents, the data were organized in a

matrix of constructs according to a timeline. The facts, impressions and elements relating to each construct were plotted in the matrix, and, when this was the case, new constructs that emerged from the data were added. Based on the evidence of the importance for the learning process in focus, we prioritize and organize the constructs in categories. Fig. 2 illustrates the data analysis process.

At this point, the investigators had developed clear relationships between categories; in fact, they were all connected in an integrated system of components required for SL and, thereafter, learning at the individual, organizational and system levels. An analytical framework (Fig. 3) is proposed to graphically represent the categories and elements and their connections.

From the interactions drawn from the business learning process in Fig. 3, it was possible to set indicators for learning processes at the three levels that supported the analysis of how SL in a CoP resulted in organizational learning: cutting across individual, firm and systemic instances.

4. Findings

The findings are described according to the categories within and relationships among elements of the analytical framework in Fig. 3. First are the features of a CoP, following Reed et al. (2010, p. 5), as a privileged locus for SL, which is presented in section 4.1. Second, the framework represents SL interacting in two ways: contributing to and receiving insights from experiences at the individual, organizational and social system levels (Ofei-Manu and Shimano, 2012; Salter and Kothari, 2016; Wenger, 2000). Section 4.2 demonstrates this through the Braskem case.

4.1. The CoP promotes social learning: EPC adaptation working group

The starting point for the Braskem project aimed at developing business adaptation strategies was the engagement in a CoP through the EPC group (Campos et al., 2016). The strengthening of the ties among these professionals occurred throughout the frequent and planned meetings. The group recognized the **facilitation from the academy as legitimate** due to its role in knowledge production and systematization and capacity building. Such facilitation was key for establishing **‘peer to peer’ equal relationships** regardless of the specific positions held by the participants in the firms.

Both Braskem's SD manager and analyst pointed out that besides providing factual knowledge, the **CoP was the environment for acquiring technical and social abilities, individually and**

Table 1
Data collection: sources and interactions.

Year	Working group meetings	Semistructured interviews	Other events	Archive analysis
	# Interaction	# Interaction	# Interaction	# Interaction
2014	4 Around 20 firms undertaking adaptation agendas. Braskem was represented in all meetings, mainly by the SD manager.	4 SD manager on the first stage (three steps) of the adaptation plan development	1 Final meeting of the EPC working cycle: around 20 firms took part, the SD manager represented Braskem	2 Braskem strategic plan and annual report
2015	4	4 SD manager on the second stage (three steps) of the adaptation plan development	1 Event to launch the publication with the experiences of 5 firms, including Braskem, represented there by the SD director and manager	2 Study based on climate projection data commissioned by Braskem and the EPC adaptation planning tool
2016	3	2 SD manager and analyst on the preparation and beginning of adaptation plan implementation	1 Side event at COP22: Braskem's SD manager presented the firm's adaptation plan	2 Braskem's map of relevant stakeholders and adaptation plan
2017	2	2 SD manager and analyst to validate the data collected so far and gather information about the implementation process and initial results	1 Side event at COP23: Braskem's SD director and manager presented the expansion of the firm's adaptation plan and the measures under implementation	1 First monitoring and evaluation report of the adaptation plan

Source: Authors

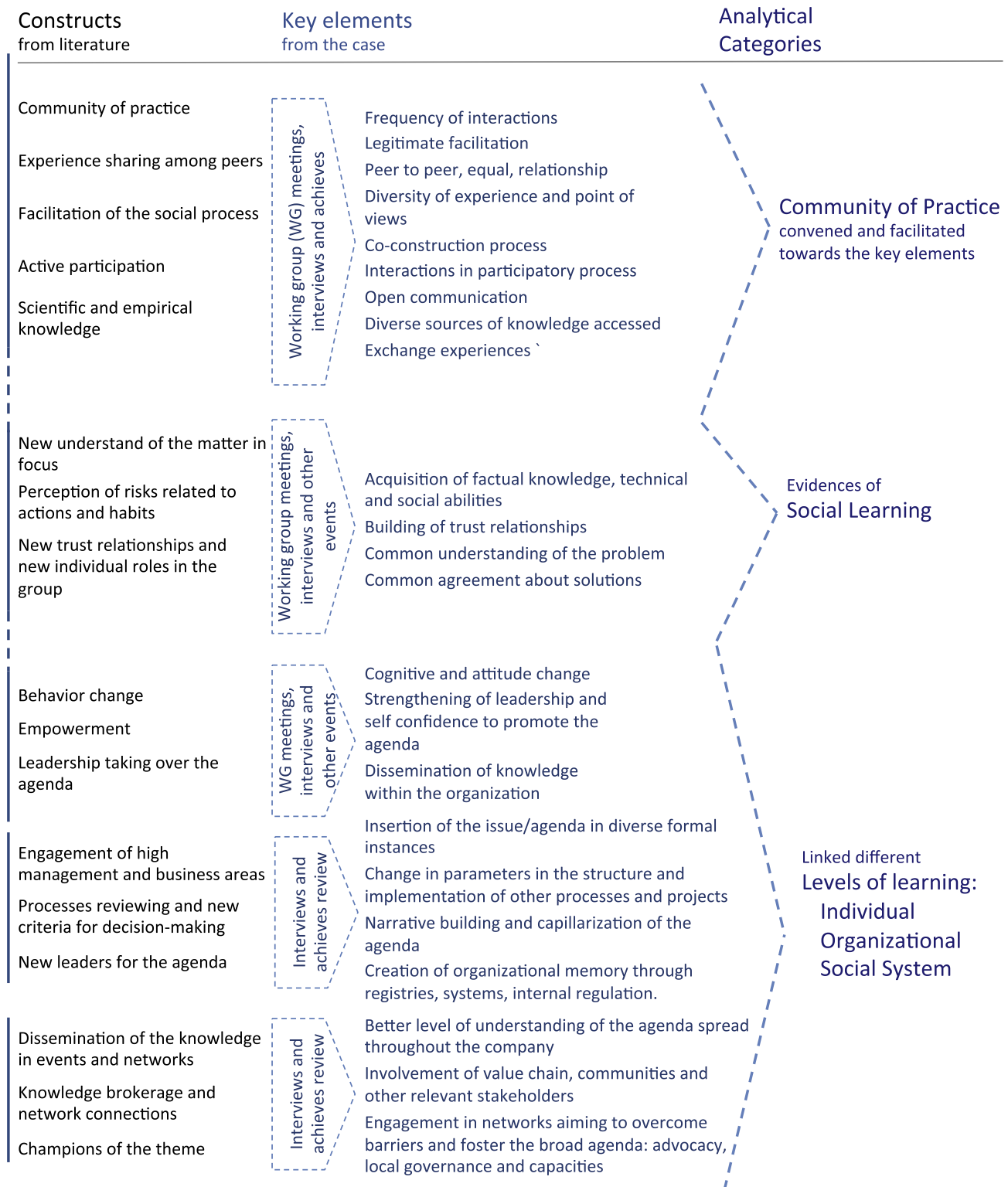


Fig. 2. Data analysis process from constructs to analytical categories.
 Source: Authors

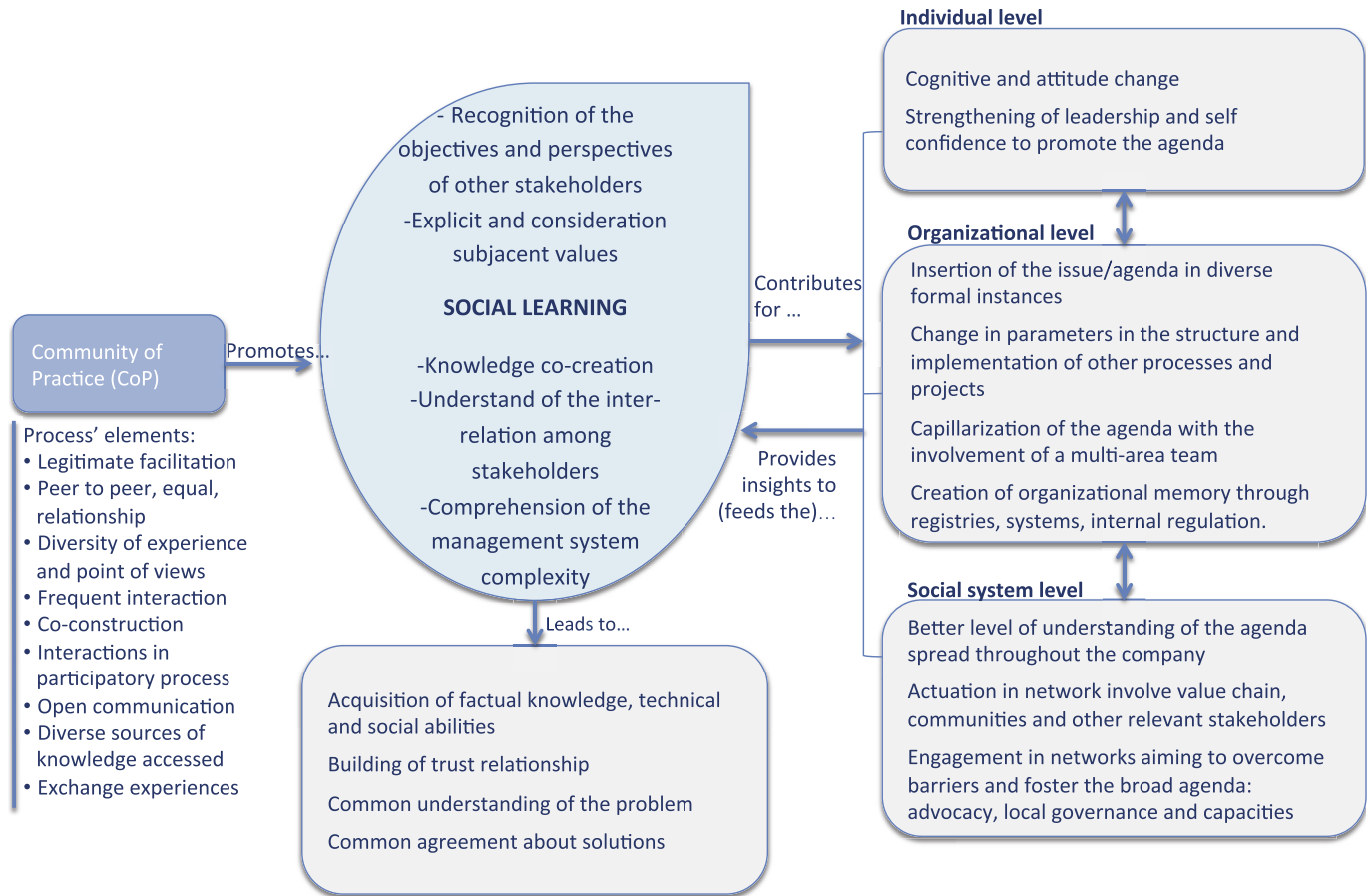


Fig. 3. SL analytical framework.

Source: Authors based on Muro and Jeffrey (2008: 332)

collectively. That was enabled by the trust relationship built with the EPC technical staff, which, in turn, had as pillars the facilitation linking scientific knowledge to participants' experiences and the frequent interactions. The co-building of common understandings and shared solutions was a consequence of this dynamic within the CoP and resulted in a collective comprehension of the complex management system for climate adaptation, materialized in the EPC framework (Fig. 1).

4.2. Social learning implications and feedback at the organizational level: Braskem learns from the CoP and provides insights to it

The narratives from Braskem's SD director, manager and analyst highlighted the direct connection between what occurred in the firm and within the CoP during the first years of the EPC and Braskem's adaptation agenda (from 2014 to 2017). Examples brought by them showed that **Braskem's representatives reached a new understanding and found support to undertake the adaptation agenda within the firm**. Stated thus, our main findings relate to how this happened throughout the individual, organizational and wider social system levels, inaugurating the complex learning dynamic required for adaptive capacity building to face climate change.

4.2.1. From the individual to the organizational level

Based on the experience within the CoP, the firms' representatives could reach a **new level of understanding of the agenda**. In consequence, some of them felt **confident in leading the**

discussion within their respective organizations. It was in this context that the Braskem SD team advanced a pilot project and succeeded in mobilizing other internal stakeholders. Assuming the leadership of the adaptation agenda, the SD manager and, later on, the SD analyst, played a fundamental role during the project's first years.

Thus, the **individual learning acquired from the social process within the CoP** offered the grounding to inaugurate **organizational learning** within the firm.

"The role of leadership was crucial for the process. It involved seeking information and knowledge in face of the gaps and transmitting these in each new interaction with the group and to every new participant." (Braskem SD director)

Revisiting the movement undertaken to formally insert and spread the adaptation agenda in the organization, first the **corporate SD director** was engaged, followed by **all Braskem top managers**. Once convinced regarding the relevance of the matter, they supported the work at other management levels and with technical and operational staff on **disseminating knowledge and building capacity**. Directors became actively involved, the theme reached the administrative board, and a vice-president was named adaptation champion.

In 2015, **representatives of all strategic and operational areas were trained**, resulting in the **installation of the agenda in all business areas**, from the corporate to the operational staff in the plants.

Besides this corporate leadership, **a key element for the successful communication and engagement process was to make the business case to translate this socioenvironmental issue into organizational language/culture.** For instance, in the financial area, the projections were presented in terms of estimated costs, losses in case of inaction and return over investment for adaptation measures.

“Braskem’s sustainable development area led the adaptation project with the involvement of focal points of all the company’s industrial plants. Strategic areas of the company (e.g., production, logistics and HES) also collaborated. The constant interaction between the SD team and the operational site was essential to the learning process.” (Braskem SD manager)

The strategy triggered a **major process covering Brazil, Germany and the United States of America’s 36 productive units** and made it possible to drive **financial resources** to hire service providers and **engage internal and external stakeholders.** Above all, it was recognized, as stated by the SD director in an external event, as a learning trajectory implicating a change in understanding:

“Those involved in the process realized the difference between mitigation and adaptation agendas. Thus, the gaps of knowledge turned up and the team started to worry about missing material risks and opportunities. Based on that, they completely changed the actuation on adaptation” (Braskem’s SD director).

4.2.2. From organizational to social learning

Throughout the continuous exchange, the **participants of the CoP gradually recognized and understood the different contexts and objectives of the firms** as well as the common aspects of business adaptation agendas. An illustration on how the

organizational learning fed back to the group is provided by Braskem assessing and interpreting climate scenarios. While advancing in adaptation planning, Braskem faced several difficulties and uncertainties, but the **diagnosis based on present and future scenarios** offered blunt evidence that climate change represented risks that might significantly impact business operations and competitiveness (Fig. 4). Sharing an understanding of **how to assess and translate climate scenarios into business language was a crucial contribution from the firm to the group.**

The Braskem experience made clear the importance of **combining science-based information and empirical knowledge** to support strategic and operational decisions. From that point, the **group co-created**, with the support of the EPC staff and in dialogue with other specialists, **recommendations for dealing with uncertainties.**

To understand further the cross-pollination between the SL and the organizational management, the following subsections delve into the dynamics between individual and social system levels.

4.2.3. From the organizational to the social system level

The Braskem team explicitly faced the need to **involve external stakeholders**, especially in two steps of the adaptation planning: when assessing past and future scenarios and when prioritizing adaptive measures. Later on, when starting to implement the adaptation plan, it became necessary to **act in networks and influence public policies and processes.**

To assess climate variables for specific locations within the needed timeframe, Braskem established a direct channel with the National Institute for Special Research (INPE in the Portuguese acronym). The first contact was due to INPE participation in an EPC meeting; for the subsequent discussion and to work on the data provided by the INPE, the company hired a consultancy.

“Braskem internal collaborators learned through the process, as well as the INPE and the consulting firm. INPE learned how to invest

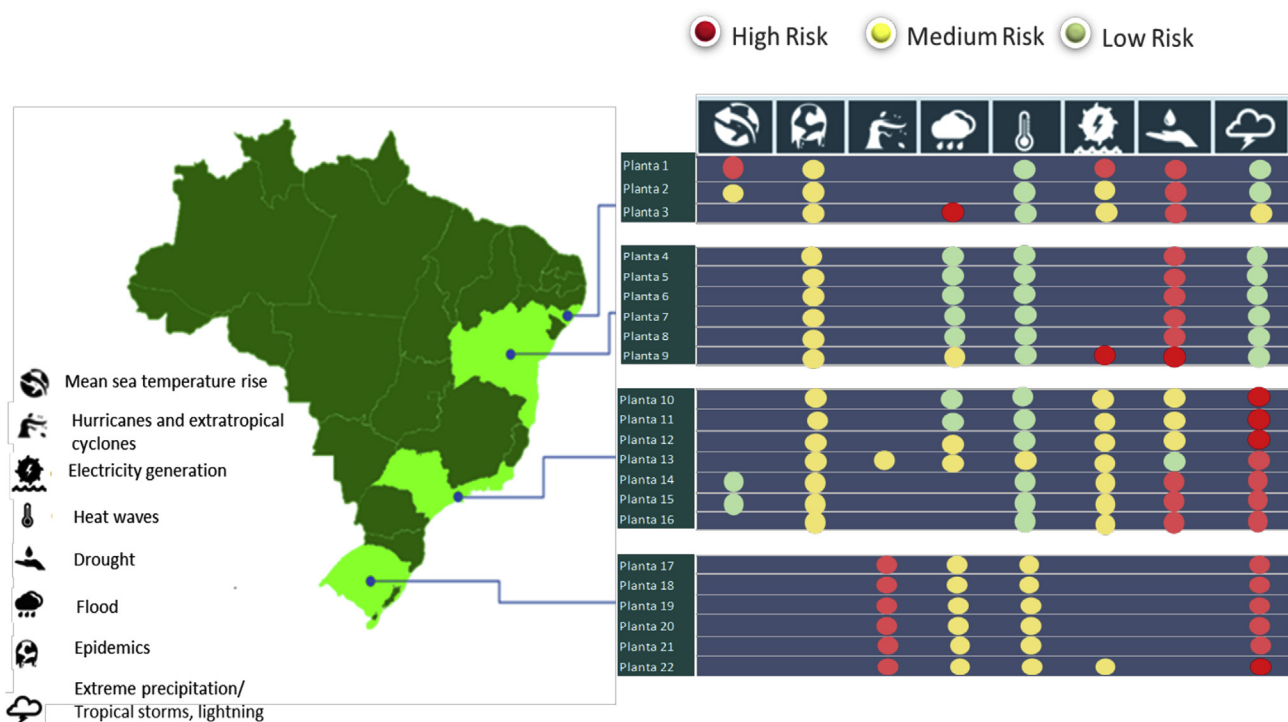


Fig. 4. Physical risks concerning Braskem's Brazilian operational sites. Source: Braskem (2018).

efforts so as to adequate the language to business interlocutors and included the atmospheric discharges in the variables covered in climate scenarios.” (Braskem SD manager)

In this way, based on **internal and external collaborative arrangements**, a **three-fold learning process** was established **between the CoP, organization, and broader social system levels**: learning with the EPC group; internalizing the agenda and mainstreaming adaptation strategy throughout the whole company; contributing back to the EPC group; and advancing on implementation while fostering other sectors' and organizations' agendas.

5. Discussion: value creation and learning indicators

First, the case study confirmed that the EPC group worked as a CoP, following the features and functions attributed to this institution in the literature (Handley et al., 2006; Salter and Kothari, 2016; Wenger, 2000). Second, it showed that the SL within the CoP offered a framework for individual and organizational learning (Handley et al., 2006), creating value for those levels (Wenger et al., 2011) and reaching the broader social system. Finally, by shedding light on this complex learning dynamic, the case provided relevant inputs into learning indicators.

That said, this section discusses (i) how value was created by Braskem throughout the adaptation planning process supported by the SL and assumed as a three-fold learning process; (ii) the main elements for social and organizational learning to interrelate by the process with each level enhancing the other; and (iii) indicators that could contribute to the challenge of assessing the effectiveness of SL processes at the organizational level (Medema et al., 2016), as well as at the broader social system level.

5.1. Social learning value creation for the organization

To understand the **depth of SL** and, consequently, the **extent of the value created by the company**, this analysis relates the five cycles of value creation in CoPs proposed by Wenger et al. (2011) to the Braskem experience.

The **immediate value** was initially generated for the firm representatives participating in the EPC community through **working group meetings** and **frequent interactions** among members. Interviewed in 2015 and later in 2017, the SD manager pointed out that it was from the knowledge and framework built within the CoP that they **realized the relevance of the agenda for Braskem's business**. Later on, when others in the firm got involved, the inputs from the CoP into the project remained crucial for **overcoming the potential inertia in the face of the technicality of the theme and the high level of uncertainty**. The collective dynamic inspired the innovation and credibility that many theories suggest is directly related to organizational learning and competitiveness (Kaplan and Norton, 1992; Osterloh and Frey, 2000).

Considering that **potential value** is composed of the generated tangible and intangible capital to be applied hereafter in the organization, the **co-constructed framework for business planning on adaptation**, as a guide and method, is one of the tangible products of the CoP activities that marked the Braskem learning experience. Regarding the intangible capital generated, it was reported in the interviews that **firm representatives had grown more prepared and confident to lead adaptation actions as well as to mobilize and engage other professionals and areas**. The diagnosis stage – the identification of risks and opportunities – emblematically set the potential value creation for the multi-area internal working group. It was at that point that this group

recognized the learning process.

“The diagnosis stage was an intense learning process. The group realized that actions related to adaptation were already in course, but in an unstructured way and not considering the intersections and implications to the climate agenda.” (Braskem's SD analyst)

The **applied value** is achieved when the knowledge is used in a concrete situation within the organization. This occurred when Braskem integrated climate risks into its business risk system for all sites around the world: in 2017, 33 adaptation actions were in approval phase and 13 under implementation just in Brazil.

With regard to the **realized value**, the literature recognizes that this level is difficult to apprehend as most of the adaptation measures are medium and long term and intrinsically attached to other actions and strategies (Rittel and Webber, 1973). The sustainable development team recognizes as a great achievement the fact that the processes they led resulted in **adaptation plans for the whole company**. From the perspective of organizational governance, the realized value is shown by the **incorporation of climate lenses in the routines of different business areas**.

“The strategic planning team cannot plan raw material and production for 2025–2030 without considering some aspects, for instance, the water stress in regions where it is planned to increase the production.” (Braskem representative)

The **reframing value** is achieved when the learning process leads to the reconsideration of organizational strategies, goals and values. Three elements determined the achievement of this level of value in the case study: the **realization of the materiality of the climate change agenda** to the company; the **potential to work on adaptation through concrete measures connected to current projects**; and the **climate change criteria inserted in investment decision-making**. Based on that, two facts respectively demonstrate the **review of goals and values**: adoption of new templates for budget planning and performance evaluation; and a stronger engagement and partnering culture with other sectors and stakeholders, including the value chain.

5.2. Inter-related social and organizational learning processes

The case study provided evidence that Braskem went simultaneously through a social and organizational learning process, which is demonstrated by the **dissemination of adaptation** within the company, **change in the understanding** of the theme, and **behavior change** (Maon et al., 2010).

The goals and metrics monitored and systematized by the corporation and the climate lenses applied to different areas show that the **lessons become routines** that guide behavior (Levitt and March 1988). Facts show that the **learning was widened and institutionalized**, in particular i) changes in the company's perception of self-sufficiency related to climate change issues, ii) an organizational process to engage other stakeholders, and iii) the knowledge acquisition and interpretation generating organizational memory (Huber, 1991).

The technical translation and further internal communication and engagement are some of the biggest challenges for companies willing to inaugurate learning processes for climate adaptation (Levitt and March 1988). Braskem was able to overcome such barriers due to interactions in the CoP, with the INPE and a consultancy firm. **In turn, the CoP was enriched by the experiences and lessons from the organizational learning process** that took place in the company studied, filling gaps and enhancing the results of both

processes. The Braskem representatives participated in SL and, in parallel, undertook an organizational learning process based on external and internal cooperation (Armitage et al., 2011); they also built on the **multistakeholder dialogue required at each step of the adaptation planning process** (Huntjens et al., 2012).

5.3. Indicators and framework for a business learning process

The Braskem case attests to the analytical framework (Fig. 3) here proposed to systematize how organizational learning has taken place from a SL process, fed back the learning into the CoP and supplied this knowledge throughout the broader social system. Moreover, useful tangible indicators emerge from the case analysis to make it possible to assess this potential subjective process at the individual, organizational and social system levels, triggered and anchored in SL dynamics. The proposed learning indicators are presented in Table 2.

The proposed framework and indicators inaugurate an innovative approach to the analysis of the extent to which internal changes in stakeholders' understanding, norms and values have taken place based on SL processes (Medema et al., 2016). Its innovation lies in the systemic view of the different levels necessarily involved in wicked problems in order to understand and foster organizational change, which is a key element in resilient socio-environmental systems (Betsill and Bulkeley, 2007; Kousky and Schneider, 2003).

5.4. Social and organizational learning: contribution to the literature and practice

In times of constant change, companies must learn constantly and efficiently (Maon et al., 2010), and organizational learning is understood as central for this process (Fortis et al., 2018). CoPs, in turn, are recognized facilitators for organizational learning (Ortiz et al., 2008) as they promote social interactions where knowledge emerges (Fortis et al., 2018). The case study in this paper contributes by integrating the levels of learning, thus widening the analysis and potentially the perspective of managers and decision-makers when acting to address wicked problems. It exemplifies how the combination of three levels of learning promoted efficiency and innovative changes in management practices required

by new climate patterns, breaking down the usual analytical silos that are inadequate for the novel strategic corporate sustainability strategy required to systemically advance new socioenvironmental agendas. In this way, this paper ultimately contributes to sustainable development as a whole.

Practical recommendations emerge for professionals facilitating CoPs and managers aiming to lead the adaptation agenda in organizations. In summary, for the facilitators the following are recommended: propose and agree with the group on a pragmatic working plan based on a legitimate method – a framework is helpful; promote frequent interactions including both face-to-face meetings and online information exchange; shed light on the conflicts and difficulties faced by each participant, not just on the achievements and advances; and engage in dialogue with other specialists and practitioners who can share specific knowledge, information or solutions in each step of the collective pathway.

For organizations' managers, it worthwhile to detach: use the CoP's staff support in order to build a narrative connecting the risks from climate change to the core business; engage internal champions based on the business narrative customized to each area; identify, in each step, the internal and external stakeholders to be involved, either for simple consultation or as partners; promote a comprehensive internal capacity building program, involving those from upper management to the operational staff; identify the multi-area committees and articulate ways to insert the matter in their agendas; and structure the knowledge management of the experience from the beginning and systematize and communicate the results.

6. Conclusion

Through a single case study, this research offers new elements to bridge the gap in the understanding of the dynamics at the organizational level within SL with respect to environmental issues. Based on the Braskem experience, it investigates how organizational learning takes place in the context of a SL process, enabling organizations to develop anticipatory adaptation to climate change, to feed this information back into the CoP and influence the agenda in a broader social system.

In that way, the case shows how a large company could integrate knowledge and materials from a CoP into routines and procedures

Table 2
Indicators for learning processes at the individual, organizational and social levels.

Level of learning	Indicator	Indicator applied to the Braskem experience
Individual level	Broad perception of adaptation and its materiality	800 leaders and the high management trained
	Leading role assumed by professionals participating in the CoP	SD team led the development of the adaptation plan internally and systematically
Organizational level	Incorporation of adaptation in the work routines	Different business areas incorporated the theme in their routines
	Climate risks inserted in risk analysis and management	Climate impacts are in the risk matrix, and climate lenses were applied in other agendas
	Climate scenarios considered in projects and investment analyses	Climate risks and costs considered in the investment analysis
	Responsibilities, goals and metrics related to resilience spread among business areas	Site focal points aware of main risks and opportunities and leaders have adaptation topic in their regular meetings
	Internal databases systematizing damages and losses, adaptation measures and their results	Metrics and parameters related to climate change inserted in the firm's knowledge management system
Social system level	Formal and informal instances of internal multi-area collaboration to adaptation cycle	Informal instances created among facility teams for risk identification and elaboration of action plans
	Stakeholders involved in the adaptation cycle, including implementation of measures	External stakeholders involved in different steps: governmental bodies, technical consultancies, academia, suppliers, ABIQUIM ^a , the press
	Learning reaching other groups and networks	Strengthened participation in national and international networks related to adaptation – e.g., UN Global Compact, Basin Committees
	Organization pushing the broad agenda	The Braskem experience became a reference for and has inspired other private and public sector organizations

^a ABIQUIM is the chemistry industry association in Brazil.

for strategizing, planning and practicing in all its business units in three countries. The Braskem experience also emphasizes that adaptation to climate change at the organizational level challenges existing learning practices and thus demands engagement from diverse areas and management levels in the learning process, as well as in multi-area instances of governance. The case studied also attests that the CoP confers legitimacy and credibility to the guidance and to the solutions identified to deal with the challenges faced during the adaptation project.

Thus, this paper demonstrates the relevance of combining SL and organization learning processes in a structured way to consistently build resilience at the organizational and social system levels. By analyzing the interactive process of social-organizational learning and proposing indicators, the paper contributes to the practice of business professionals willing to lead or strengthen the adaptation agenda and to support organizations that facilitate SL within CoPs.

The limitations of the research relate to the singularity of the case study. In addition, there was no attempt to isolate and/or qualify the influence of SL on the organizational process. Future research could apply the analytical framework and test the indicators in other firms with different profiles and adjust and improve them. Another potential direction of future research is to further explore the implications of the relationship between organizational learning and the social system level.

Declarations of interest

None.

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